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ANIMAL MUSIC, ITS NATURE AND ORIGIN.

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THE songs of birds and the few other animals that sing, have almost exclusively been treated of in the world of sentiment, where poet-naturalists and nature-poets have culled a wealth of fancies that will endure as long as there is human emotion, but which count for little in the field of exact knowledge. They are choice reading; a kind of pleasure gardens. The purpose here is simply to bring together such songs as have been written in musical notation, and from this compilation to make whatever inductions may seem of scientific value to ornithologists, physiologists, psychologists and theoretical musicians, whose studies touch this subject.

The young bird acquires his song by traditional inheritance; that is, each brood, endowed by physiological inheritance with a certain aptitude, learns, after long practice, by constantly hearing the song of its elders, the melody peculiar to that species, which is in turn similarly transmitted to the succeeding generation. In conclusive proof of this is the fact, that a young nestling reared by foster-parents of some other species will learn their song. Hon. Daines Barrington (1),[1] an early and discriminating observer, says, "I have educated nestling linnets under the three best singing larks, the skylark, woodlark and titlark, every one of which, instead of the linnet's song, adhered entirely to that of their respective instructors." This process seems very decisive, for a titlark-linnet (a linnet educated by a titlark), well fixed in song, which he kept for three months with common linnets in full song, borrowed no passages, but adhered to the titlark melody. It

[1] The references are made by Roman numerals to the list at the end of the article.

is evident, therefore, that birds acquire their songs as infants acquire a language, by instruction rather than by instinct; and that those of the same species sing alike for the same reason that children of one nationality speak alike, viz: that their instructors have a common tongue.

The next question is, how birds came originally by the notes which are peculiar to each species. Daines Barrington answers this also, saying substantially that scarcely any two birds of the same species sing exactly alike; there are, so to speak, "provincial dialects" in different districts, as well as individual mannerisms and defects. All these minor differences, continually renewed, will be imitated by the young birds, and passing from them to succeeding generations, will be perpetuated and grow to wider divergencies. The loss of a parent at the critical period, also, will compel the young bird to invent or copy from other birds, perhaps of different species. Had this explanation been thought out a hundred years later, in 1873, it would have been added that of all these variations sexual selection would perpetuate the most agreeable, so that, as Darwin says (II, p. 378), "It is not difficult to imagine the steps by which the notes of a bird, primarily used as a mere call, or for some other purpose, might have been improved into a melodious love song."

The ultimate origin of melody is a more difficult problem. Darwin writes elsewhere (II, p. 569), "But if it be further asked why musical tones in a certain order and rhythm give man and other animals pleasure, we can no more give the reason than for the pleasantness of certain tastes and smells." I will attempt here to briefly answer this question, reserving at present the fuller statement of a theory, which, very strangely, has never before been hit upon, though Darwin in the paragraph preceding that just quoted, and Helmholtz (III, p. 553) have almost come upon it, and then passed by.

A musical sound is compound in its structure, being really a group of simple tones heard simultaneously; in fact, a chord. This group is composed of a ground tone or fundamental, which predominates, and of a number of overtones, that decrease in intensity as they rise in pitch through a series of harmonic intervals. Thus between the ground-tone and over-tone No. 1 is the interval of an octave; between Nos. 1 and 2, of a fifth; between Nos. 2 and 3, of a fourth; between Nos. 3 and 4, of a major third (see songs No. 1). These intervals, the octave, fifth, fourth

and third, which thus occur in every musical sound we hear, and which existed as physical peculiarities of vibrating bodies long before any living being came upon the earth, are also at the basis of human and, I hope to show, extra-human melody. It is a very suggestive coincidence, too thorough-going to have occurred by chance. The thought at once arises that the peculiar, compound, harmonic structure of musical sounds (more accurately, of the vibrations which produce them) has in some way impressed itself upon the auditory mechanism; so that melody, gradually growing under the guidance of the ear thus modified, has been moulded into a musical form similar to that possessed by the group of harmonically-related tones which we have seen to compose the sounds indicated.

This seems very probable. For since each terminal nerve of the thousands in the cochlea responds to a given simple tone, the group of such tones forming a musical sound will excite a corresponding group of nerves, which will of course be related amongst themselves as are the exciting tones amongst themselves; that is, they will be serially octaves, fifths, fourths and thirds apart. Every nerve will, therefore, have always been stimulated in company with certain others, at harmonic intervals from it; and it is inevitable that the incessant and long continued repetition of this coöperate activity should have resulted in some anatomical or functional bond; a pathway, as it were, leading from each member of the group to every other. *The progress of any melody will be easiest along this harmonic pathway, worn by the physical structure of sound.*

For this reason it seems to me, "musical tones in a certain order give man and other animals pleasure."[1] Take the case of some primitive bird of the type from which the various Insessores have diverged (singing birds belong chiefly to this Order). For innumerable years the harmonic structure of sound vibrations had been impressing itself upon the auditory mechanism of his ancestors, segregating the terminal nerves, or whatever the auditory units might be, into groups, and habituating the members of each group to concerted activity. He, in turn inheriting that

[1] The word *pleasure* has been a stumbling block. Were the concretes of which it is the abstract always expressed, thus—"I feel an easy performance of some function; or a general nervous stimulation and exaltation; or an impulse to continue this sensation or action"—were this done, many seeming difficulties of physio-psychology would vanish.

modified mechanism, began to sing, at first a single note. When this grew wearisome and for remedy the pitch was altered, true song arose. But the change of pitch could hardly have been at haphazard; the first note excited a nerve belonging to a certain coherent group, and it was a necessary alternative that the next note should excite some other nerve, either within or without that group. If within, the combination had occurred millions of times; if without, perhaps not once. I cannot doubt that the change was within the group; was harmonic; indeed the overtones of the first note had already slightly stimulated the related nerves, so that their faint tremor extended, as it were, an invitation to touch them more firmly. The invitation was followed, and then other similar ones, and finally the song grew harmonic, because it followed the easy, preëstablished pathway, rising and falling octaves, fifths, fourths and thirds from one to another of the many-grouped nerves. He sang to please himself or his mate, and the most pleasing combination of notes was that most easily heard; the combination producing least friction and securing the most economical action of the sound-receiving apparatus.

In this brief exposition all details are neglected, and even inexactness admitted where rigorous truth of statement would consume too much space. The more technical treatment of the theory, if it can be called that, belongs to physiological acoustics, in which province many facts tend to its support. The further evidence that can be appropriately presented here, consists of certain statistical proofs gathered from the bird songs which occupy the last pages of this article, and it seems very conclusive.

There are four hundred and six intervals in the thirty-eight bird songs. Of these, all below the major third may be considered as a "filling in"—material for runs, trills, etc.; they number one hundred and eighty-four.

The major third and the intervals above it are the true progressive steps followed by the bird's ear in the long leaps of his song; there are of these two hundred and twenty-two. The following table will show the details:

Interval	Maj. 3d.	4th.	Dim. 5th.	5th.	Mi. 6th.	6th	Dim. 7th	7th	8th.
No. of tones . . .	2	2½	3	3½	4	4½	5	5½	6
Absolute No. . .	58	55	5	60	12	8	4	. . .	20
Proportional No.	26 per ct	25 per ct	2 per ct.	27 per ct	6 per ct.	4 per ct.	1 per ct.	. . .	9 per ct.

These results are as pregnant as they are simple. The perfect fifths, fourths, thirds and octaves have a marked predominance, their proportion of the whole number being respectively twenty-seven per cent., twenty-five per cent., twenty-six per cent. and nine per cent., or taken all four together, eighty-seven per cent. as against thirteen per cent. of the remaining five intervals. Nearly all the songs illustrate this pronounced harmonic character; that of the song sparrow (Nos. 18–22), for example, in which the best intervals lie between the trills, is very good. Indeed, the very fact that various keys are selected in which to write bird songs is proof that they rest on the same basis as human music. And the immense preponderance of harmonic intervals seems sufficient answer to whatever may be said about the difficulties and possible inaccuracies attendant on the writing of these songs.

There are some curious observations on the singing of birds in concert which seem to show that they have an "ear for music." Daines Barrington (I) says that, as tested by trained ears, a dozen singing birds of different kinds in the same room made no disagreeable dissonance. And Mr. Augustus Fowler writes me that in a meadow where many red-winged black-birds are congregated, one may "hear their familiar notes pitched to the same key; not a discordant note is uttered because the intervals are thirds, fifths, etc." In a concert of male goldfinches, when they sing for an hour together, "although one may pitch his tune and commence singing, the others following, begin their tunes on the same pitch, and to an unpracticed ear, or to a casual observer, their notes seem discordant, when they are in perfect unison."

What few songs of other animals than birds can be gathered, point even more strongly in the same direction. Darwin (II, p. 567), speaking of the *Hylobates agilis*, an ape allied to man, says, "This gibbon has an extremely loud but musical voice. Mr. Waterhouse states (XVI), 'It appeared to me that in ascending and descending the scale, the intervals were always exactly half-tones, and I am sure that the highest note was the exact octave to the lowest. The quality of the notes is very musical; and I do not doubt that a good violinist would be able to give a correct idea of the gibbon's composition, excepting as regards its loudness.' Mr. Waterhouse then gives the notes. Prof. Owen, who is a musician, confirms the foregoing statement. This gibbon is not the only species in the genus which sings, for my son, Francis Darwin, attentively listened in the zoölogical gardens to *H. leu-*

ciscus whilst singing a cadence of three notes, in true musical intervals and with a clear musical tone."

The Rev. S. Lockwood writes in the AMERICAN NATURALIST (VI) of a most interesting singing mouse, *Hesperomys cognatus*, and fortunately gives the music, written by his son (Song No. 39). He says, "Although she had no ear for time, yet she would keep to the key of B (two flats) and strictly in a major key. Her soft clear voice falls an octave with all the precision possible, then at the wind up it rises again into a very quick trill on C sharp and D. When singing whilst turning in her wheel, and suddenly thrown on her back by its stoppage, as if in surprise, she would roll off four or five notes in a higher octave, and in a greatly increased loudness of voice.'

In answer to some inquiries, Mr. Lockwood kindly writes me as follows: "Octaves, fifths and thirds were usually selected for the long intervals of *Hesperomys*' song. I have had and still have singing guinea pigs, *Cavia cobaia*. What is said of my *Hesperomys* is in the main true of the *Cavia*. There are other rodents that sing, *Mus musculus*, or house mouse; the rat, *Mus rattus*; the white-footed mouse, *Hesperomys leucopus*; the woodchuck, *Arctomys monax*, and the squirrels." Recent numbers of *Nature* (VII) and the *Popular Science Monthly* (VIII) contain brief accounts of singing mice. That in the former confirms some curious phenomena observed by Mr. Lockwood—the singing of an air with an accompaniment, and the influence of fright as well as joy in starting the song.

It is doubtful whether true music is produced by any invertebrates. There seems to be no provision in the ear for the exact discrimination of pitch, and the sounds are instrumental rather than vocal, being generally produced by stridulation. Some references, however, are given with the others to what has been written on this subject (XXII to XXVI, see also II, pp. 274, 289, 301).

For assistance in my work of collecting and studying animal songs I am much indebted, especially to Mr. Wilson Flagg, Prof. E. R. Sill, Dr. Elliott Coues, Rev. S. Lockwood, Mr. H. A. Purdie, Mr. Robert Ridgway, Miss Alice Bacon, Mr. H. D. Minot and Dr. P. L. Hatch. It was necessary that the work should be largely one of compilation, for the material had never been brought together before. Thus the attempt has much of a pioneer character, and my chief hope is to direct attention to this important field of study, where acute observation is very much

needed; for the comparative sciences hold the keys to all questions of origin, and their method is simply the intelligent noting and collating of the facts of Nature. Allegiance to this method in the field of animal music has even at this early stage resulted in two encouraging starting points for future work—a statistical demonstration of the harmonic character of animal, especially bird, song; and a theory for the origin of melody, whether human or extra-human, which besides the usual basis of physiological acoustics, employs the law of modified, inherited, selected and adapted structure, *i. e.*, the law of evolution.

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VII. "Singing Mice, *Nature*, Nov. 8, 1877, p. 29.
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XII. "Music of Nature," by Gardiner. London, 1832.
XIII. "Book of Nature," by Good, p. 189. Hartford, 1853.
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XVI. Given in W. C. L. Martin's "General Introduc. to Nat. Hist. of Mamm. Animals," 1841, p. 432; Owen, "Anat. of Vertebrates," Vol. III, p. 600.
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XVIII. Kennedy. *N. Abhandl. baier. Akad.* (*Phil. Abhandl.*), 1797, p. 169.
XIX. Savart (*Froriep's Notizen u.s.w.*), 1826, pp. 1 and 20.
XX. Brehm and Hausmann, *Naumannia*. 1855, pp. 54, 96, 181.
XXI. *Journ. für Orn.*, 1855, p. 348, 1856, p. 250.
XXII. "The Songs of the Grasshoppers," by S. H. Scudder, AMERICAN NATURALIST, Vol. II, 1868, p. 113.
XXIII. "Stridulating Crustaceans," *Nature*, May, 1878, pp. 53 and 95.
XXIV. Insect Music, Landois' *Das Ausland*, XLIII (1870), pp. 429 and 430.
XXV. Stridulation of Scorpions. See "Annual Rec. of Science" (Baird), 1877, p. 282.
XXVI. Stridulation of Butterflies, See "Annual Rec. of Science" (Baird), 1877, p. 309.
XXVII. *Language et chant des oiseaux*, par M. F. Lescuyer. (Paris, J. B. Baillière et Fils.)
XXVIII. *Il Canto Degli Uccelli*, note di fisiologia e biologia zoologica in rapporte alla scelta sessuale e alla lotta per l'esistenza raccolte du *Luigi Paollucci*, Professori di Storia Naturale nel R. Instituto Tecnico di Ancona. (Milano, 1878, pp. 130.) This is an elaborate and philosophical memoir treating of animal song in many separate aspects. The notes of insects, batrachians, reptiles and birds are given in musical notation, and elaborately discussed. No less than twenty bird songs are thus written on the gamut, and the peculiar melodic quality of sixty-eight more tabulated. We hope to review this important work in a succeeding number of the NATURALIST.

There are so many possible arrangements for these songs that it seems best to group them according to source, all from one writer in succession. No addition is made in any case to the original text; the names, vulgar or scientific, or both, are given without change. No. 1 is the fundamental C with its overtones (III, p. 33).

Gardiner's "Music of Nature" (Nos. 2–4).

2. **Lark,** England.
3. **Nightingale.**
4. **Robin.**

"The Birds of Middlesex" by J. E. Harting (Nos. 5–15).

5. **Blackcap,** *Sylvia atricapilla.*
6. **Willow Warbler,** *Sylvia trachilus.*
7. **Yellow-Hammer,** *Emberiza cibrinella.*
8. **Ring Plover.**
9. **Peewill.**
10. **Oystercatcher.**
11. **Little Ring Plover.**
12. **Whimbrel.**
13. **Curlew.**
14. **Dunlin.**
15. **Swan.**

"Birds and Seasons of New England," by Wilson Flagg (Nos. 16–31).

16[a]. **Song Sparrow,** Theme.
17[b]. " " Brisk. (The notes marked guttural seem to be performed by a rapid trilling of these notes with their octaves).
18[c]. **Song Sparrow,** Joyful.
19[d]. " " Plaintive.
20[e]. " " Fervent.
21[f]. " " Subdued and querulous.
22[g]. " " Brilliant.
23. **Peabody Bird,** *Fringilla albicollis.* (This is a corrected song, sent me by Mr. Flagg.)
24. **Vireo—"The Brigadier."**
25. **Wood Sparrow,** *Hirundo bicolor.*
26. **Whippoorwill,** *Caprimulgis vociferus.*
27. **Chewink,** *Fringilla erythrophthalma.*
28. **Chickadee,** *Parus palustris.*
29. **Golden Robin,** *Icterus Baltimore.*
30. **Green Warbler.** *Sylvia virens.*
31. **Quail,** *Perdix Virginiana.*
32. **Skylark** (caged). Sent me by Mr. Flagg.

"My Garden," by Alfred Smee. London, 1872.

33. **Reed Warbler.**
34. **Thrush.**
35. **Blackbird.**

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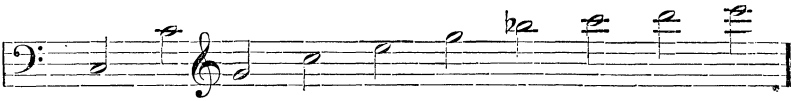
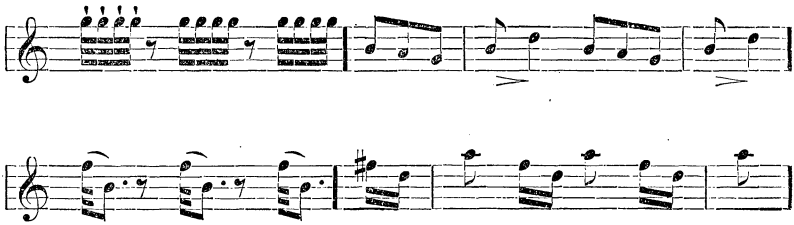
36. **Baltimore Oriole.** Call and reply. *Harpers' Mag.*, Sept., '76.
37. **Golden Oriole,** *Oriolus galbula* of Australia. *Science Gossip,* April, 1878.
38. **California Meadow Lark,** *Sturnella neglecta.* Three songs kindly given me by a gentleman familiar with music.
39. **Vesper Mouse,** *Hesperomys cognatus.*
40. **Vesper Mouse,** *Hesperomys cognatus.*

The two above songs, 39 the Wheel Song, 40 the Grand Roll, are given by Rev. S. Lockwood, AMERICAN NATURALIST, Vol. v, '71, p. 764.

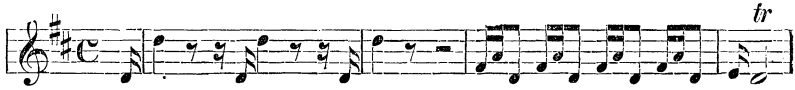
1. OVERTONES OF C.



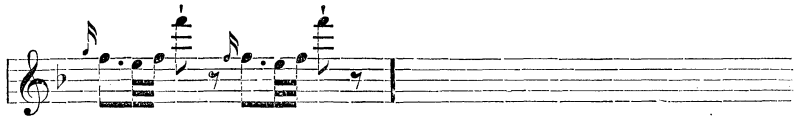
2. LARK.



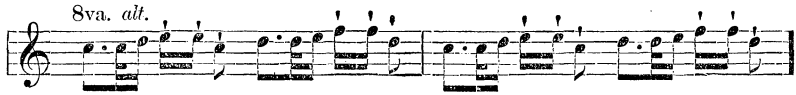
3. NIGHTINGALE.



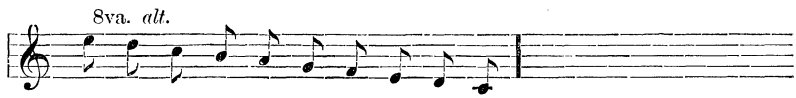
4. ROBIN.



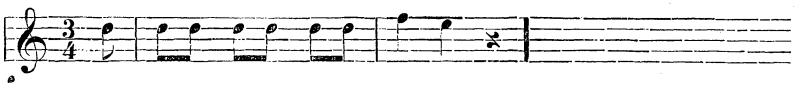
5. BLACKCAP



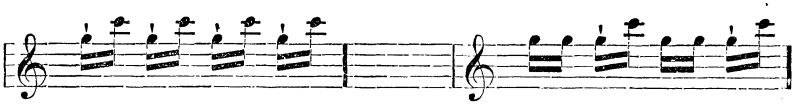
6. WILLOW WARBLER.



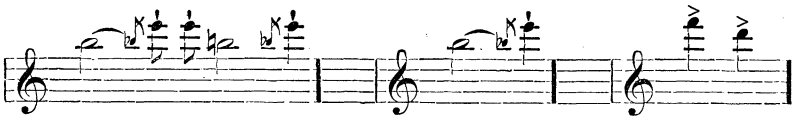
7. YELLOW HAMMER.



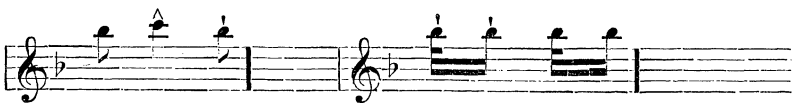
8. RING PLOVER.



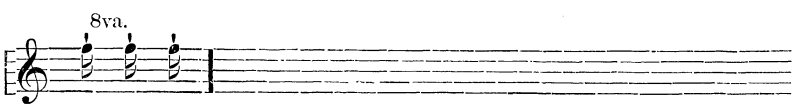
9. PEEWILL.



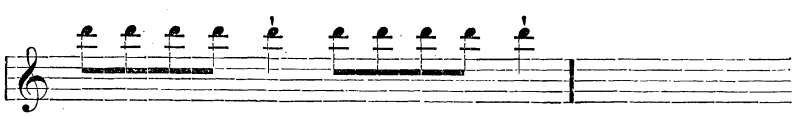
10. OYSTER-CATCHER.



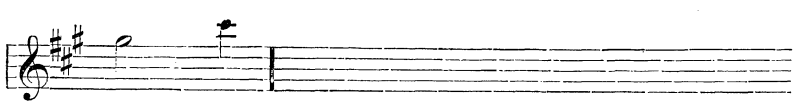
11. LITTLE RING PLOVER.



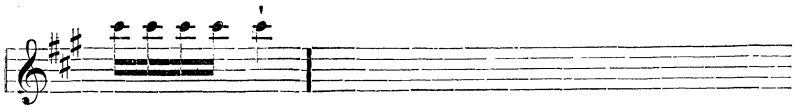
12. WHIMBREL.



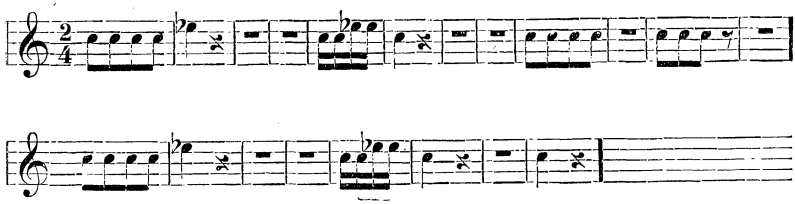
13. CURLEW.



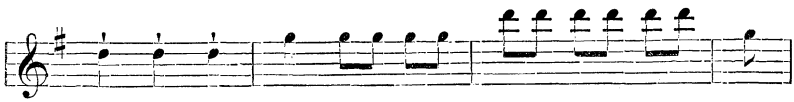
14. DULIN.



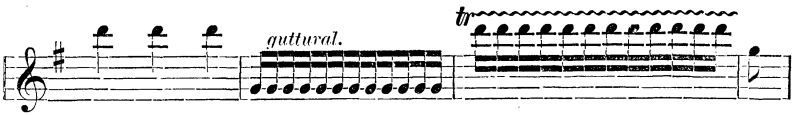
15. SWAN.



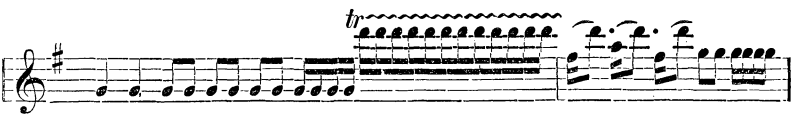
16. *a* SONG SPARROW.



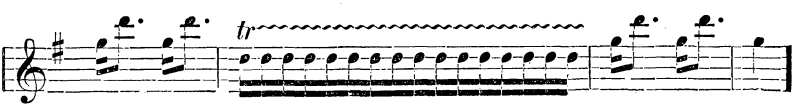
17. *b* SONG SPARROW.



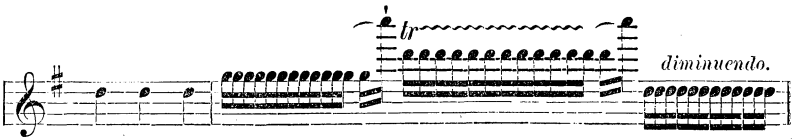
18. *c* SONG SPARROW.



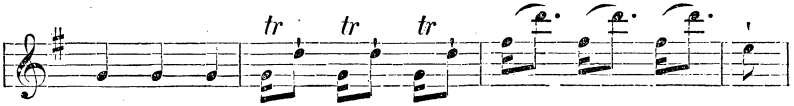
19. *d* SONG SPARROW.



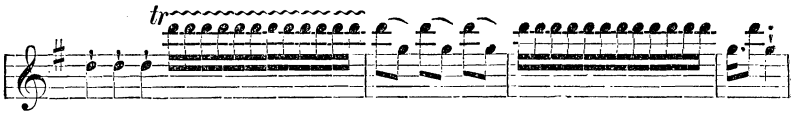
20. *e* SONG SPARROW.



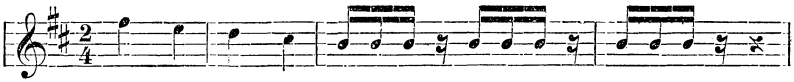
21. *f* SONG SPARROW.



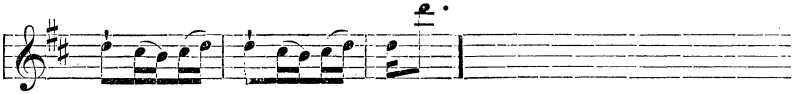
22. *g* SONG SPARROW.



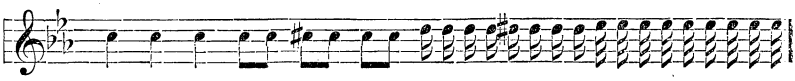
23. PEABODY BIRD.



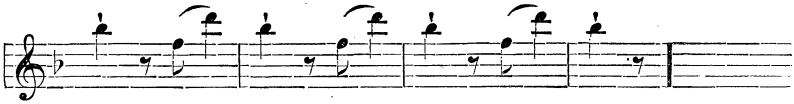
24. VIREO.



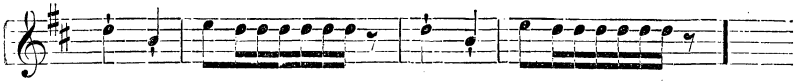
25. WOOD SPARROW.



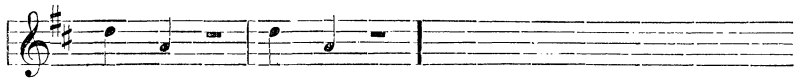
26. WHIPPOORWILL.



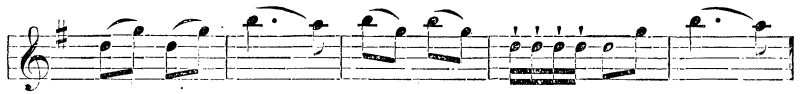
27. CHEWINK.



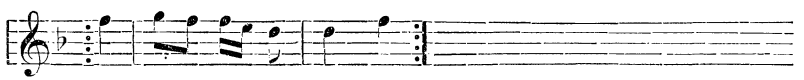
28. CHICKADEE.



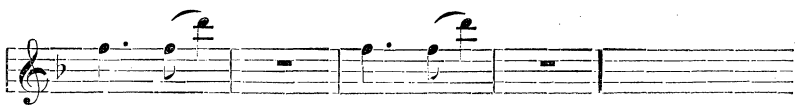
29. GOLDEN ROBIN.



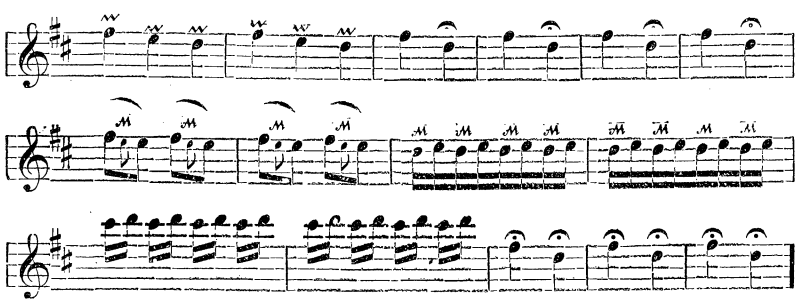
30. GREEN WARBLER.



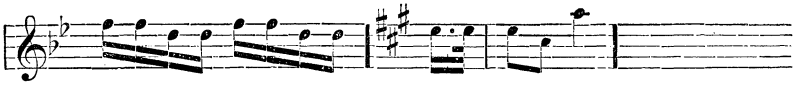
31. QUAIL.



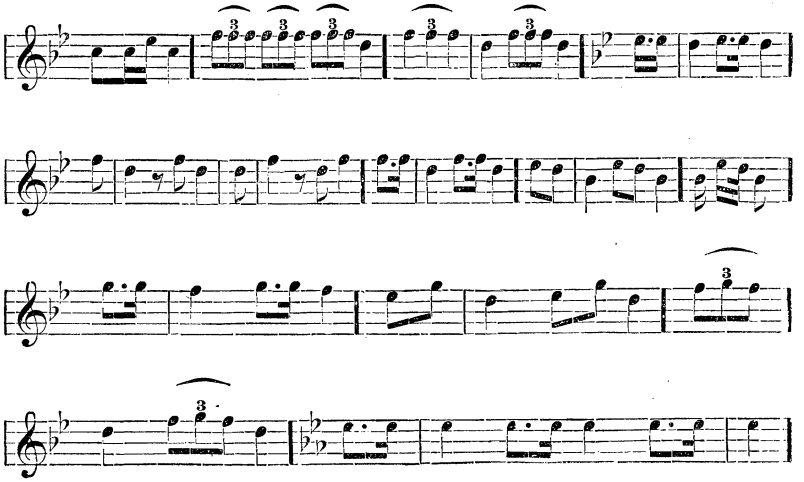
32. SKYLARK.



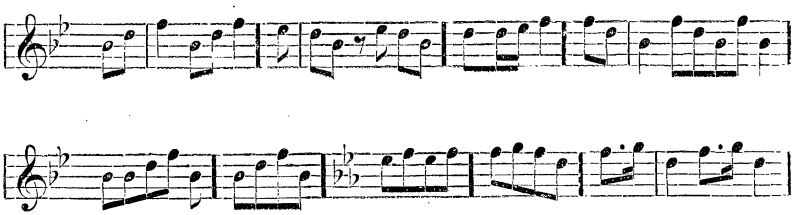
33. REED WARBLER.



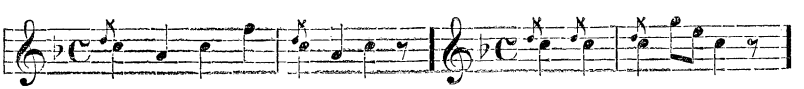
34. THRUSH.



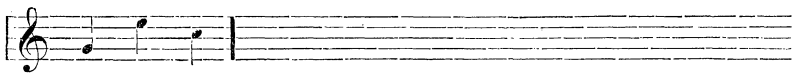
35. BLACKBIRD.



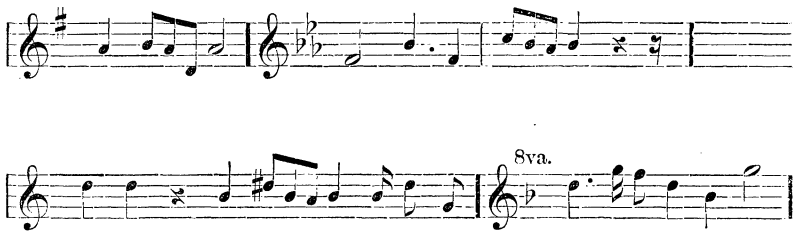
36. BALTIMORE ORIOLE.



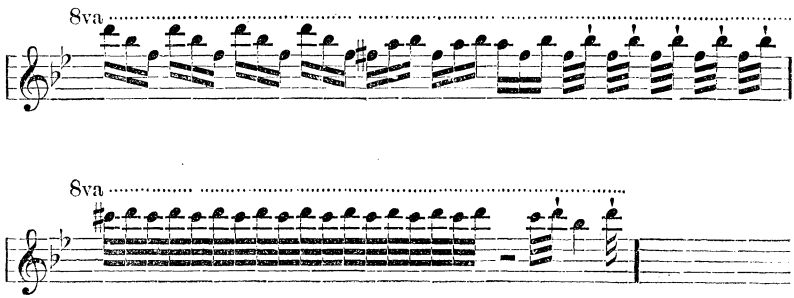
37. GOLDEN ORIOLE.



38. CALIFORNIA MEADOW LARK.



39. VESPER MOUSE.—WHEEL SONG.



40. VESPER MOUSE.—GRAND ROLL.